agricultural research

U.S.DEPARTMENT OF AGRICULTURE NOVEMBER 1975

agricultural research

November 1975/Vol. 24, No. 5

A Closed System

Dealing with pollutants is one of today's toughest technological challenges: planet earth is a closed system with limited natural processes for waste disposal.

Much of this challenge must be borne by agricultural research for agriculture is both sinner and sinned against. Agricultural activities produce sediment, manure, and processing byproducts which enter streams. In turn, industrial smoke and auto exhausts harm crops and timber. Moreover, pollutants are frequently linked in a cycle. An airborne pollutant from industry, for example, may settle on soil surface, then percolate through the soil into ground water or a stream. Indeed, interactions between pollutants and their sources are incredibly manifold. Although agriculture's contribution is increasing, the bulk of pollutants produced in our society comes from sewage and industrial wastes.

Pollution control is not a new challenge to agricultural research. Since 1888, when USDA successfully imported an insect ally to to pit against the citrus scale that then threatened California groves, it has actively pursued nonchemical approaches to insect control. The Pure Food and Drug Act of 1906, which bars contaminants from food, was conceived by Dr. Harvey W. Wiley, chief chemist of USDA. ARS research on pesticide residues and safeguarding the soil from the ravages of wind and water go back several decades.

Today's pollution fighters provide evidence that nonsoluble materials, such as phosphates, are so bound by soil particles that they move only as the particles move. Thus practices which prevent erosion—contour plowing, strip cropping, stubble mulching, among others—will curb this type of pollution. And paralleling the recycling of decayed materials in nature, ARS scientists have devised many methods for salvaging wastes, turning poultry feathers and citrus pulp into feeds, for example, and whey into confections.

Research will continue to play a vital role in coping with the national pollution problem. But the public has a responsibility too. There is a need for broader ecological awareness, so that we can better weigh the consequences of environmental actions. Concerned citizens can create a climate in which leaders and institutions make environmental decisions based on a wealth of accrued facts. Pollution must be curbed—without hampering the world-wide effort to grow more food for more people. The issue concerns every citizen. Inescapably, we are the stewards of our natural resources.—*R. P. K.*

INSECTS

PLANT SCIENCE

SOIL AND WATER

AGRISEARCH NOTES

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COVER: Fatal encounter. A gypsy moth—scourge of forests of the Northeast—struggles vainly to escape from a trap baited with disparlure, a new and highly effective synthetic sex attractant. Article begins on page 8 (0774R1068–9A).

AGRICULTURAL RESEARCH is published monthly by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, D.C. 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 15, 1977. Yearly subscription rate is $5.05 in the United States and countries of the Postal Union, $6.35 elsewhere. Single copies are 45 cents. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Information in this magazine in public property and may be reprinted without permission. Prints of photos are available to mass media; please order by photo number.

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U.S. Department of Agriculture

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Toward sturdier stalks

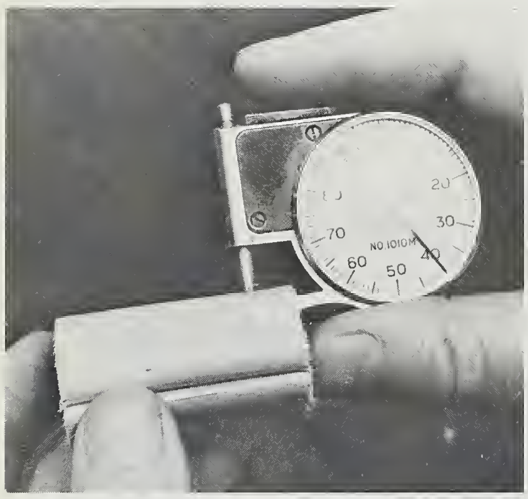
Corn breeders, who have already developed new hybrids that are vastly improved over old hybrids in lodging resistance, may continue to substantially improve upon the trait.

Many of today's hybrids are two to three times more resistant to breaking and falling over than the hybrids that were grown 30 years ago, says ARS agronomist Marcus S. Zuber. However, lodging still costs farmers 5 to 20 percent of their crop each year in harvest losses.

The problem may be caused by weather, insects, and diseases, he says, but lodging is also aggravated by high yields in thickly planted and heavily fertilized

In studies aimed at improving the strength of corn stalks, research assistants make cuttings from the seventh growth cycle for laboratory testing (0975X1774–13A).

A micrometer is used to measure the thickness of rind, a trait that is directly related to stalk strength (0975X1772–13A).



To improve corn stalk quality, scientists are attempting to develop stalks that are resistant to disease. The lower stalk was innoculated with Diplodia mydis, a fungus that can cause stalk rot via a fungus-saturated toothpick. The upper stalk is healthy, its puncture wound coming from a field strength test (0975X–1776–7).

corn as it is grown now. This tends to obscure progress that has been made in breeding for stronger stalks.

In cooperation with the Missouri Agricultural Experiment Station, Columbia, Dr. Zuber is a leader in developing strains of corn that are being used as sources to upgrade stalk quality in existing hybirds.

Dr. Zuber's technique involves measuring the amount of force required to crush a mature stalk section. He selects those plants with the highest crushing strength, and the seeds from the selected plants are planted the next generation and intermated. Thus, in one generation, selections are made and in the second generation the selected plants are intermated—this process completes one cycle. To date, six cycles of recurrent selection have been completed. The average increase in stalk-crushing strength per cycle has been about 125-load pounds. Load pounds are nearly the equivalent of pounds per square inch (PSI). How long can crushing strength be increased? No one knows, but the trend has continued to be upward through six cycles.

Strains with high stalk-crushing strength have been shown to have much more resistance to field stalk lodging. Besides showing that recurrent selection for stalk-crushing strength is an effective way to reduce lodging, the experiments have led Dr. Zuber to more observations that may be helpful to corn breeders.

Most encouraging was the finding that yield was not decreased by breeding for stalk strength in the populations he studied. This indicates improved physiological efficiency, Dr. Zuber says. He had expected that improvement in stalk quality would be made at the expense of yield because both attributes would be competing for energy available in the plant.

Studies by other scientists were not as encouraging when yield and stalk quality were compared. In those studies, however, the researchers used percentage of erect plants as the selection criterion—not stalk-crushing strength.

Dr. Zuber found that stalks produced from selections with high crushing strength did not differ from original populations in susceptibility to Diplodia stalk rot. Populations of corn that Dr. Zuber had selected for low stalk-crushing strength, however, were slightly more susceptible to Diplodia than the original populations.

In succeeding generations of stalks with high crushing strength, thickness of the rind—outside layer—increased steadily but in very small amounts. Dr. Zuber has found that rind accounts for

about 60 percent of stalk strength, and pith—the stalk's center—accounts for the rest.

As the percentage of stalk that is rind increases, one of the stalk's strength-giving constituents, called lignin, also becomes more abundant. Farm animals—even ruminants—cannot digest lignin well. Corn with a genetic trait called brown midrib–3 has stalks low in lignin content and are more digestible. Dr. Zuber is studying the effect of this trait on stalk crushing strength. These studies are being done in cooperation with plant scientists at Purdue University Agricultural Experiment Station, Lafayette, Ind.

Another concern that is raised by development of corn with tough stalks is the question of how well the stalks will rot after they have been plowed down as residue. Results of decomposition tests with buried stalks, however, show that increased crushing strength probably will not cause any problem for the farmer.

In the experiments, Dr. Zuber observed that the weights of both a bushel of corn and 500 kernels increased as stalks' crushing strength increased. Conversely, shelling percentage decreased. Shelling percentage is the percentage of weight in a bushel of ear corn that is actually grain. □

Research specialist Terry R. Colbert conducts field puncture strength test. The test indicates how many load pounds are required to push a dull needle through the rind of a corn stalk into the pith. Mr. Colbert is with the Missouri Agricultural Experiment Station (0975X1774–27).

After sawing test corn stalks into uniform lengths (below, 0975X1773–11) Dr. Zuber conducts stalk crushing tests to determine stalk strength. A load cell records the amount of pressure—in load pounds—required to crush each stalk (left, 0975X1771–25).

Stalk crushing tests are conducted on whole stalk sections and on stalk sections with the pith removed. By correlating the results of these tests, it is possible to determine the contribution of the pith and the rind to stalk strength (0975X1773–23).

Dr. Cary checks the roots of 10-day-old wheat shoots grown in a selenium solution for toxic effects caused by trimethylselenonium ion—a selenium compound that occurs naturally in the urine of animals (0875X1169–29).

New links in the selenium cycle

Laboratory technician Linda A. Hass mixes solution in a Micro Kjeldahl digestion unit. Plant samples are digested in acid, thus changing to liquids, for later determination of selenium concentration (0875X1168–20).

SELENIUM can fool you. There is not a lot of it around. But animals need it, people need it, and it seems scientists need to know a whole lot more about it.

Some new information about selenium's environmental cycle comes from ARS scientists at the U.S. Plant, Soil and Nutrition Laboratory, Ithaca, N.Y., working with scientists at the South Dakota Agricultural Experiment Station in Brookings, S.D. This effort is particularly timely in view of recent striking discoveries in this country and abroad showing that small amounts of dietary selenium may offer protection against some chemical carcinogens, and may also protect laboratory animals from toxic effects of methyl mercury and cadmium.

Chemist Earle E. Cary and director of the Ithaca laboratory, William H. Allaway, collaborated with Dr. Oscar Olson and Dr. Ivan Palmer of the South Dakota station in studying the movement of selenium through the food chain.

"Probably because of our wide variety of food, people in this country do not suffer from selenium deficiency diseases," says Mr. Cary. But diseases from deficiencies, and also selenium toxicity problems have been serious concerns of U.S. livestock producers.

Plants take up selenium from the soil in the form of selenates and selenites. "Toxic spots" on the western plains, notorious for selenium accumulating plants such as *Astragalus* species, or locoweed, are brought about by excessive selenate in the soil.

Since selenium can volatilize, the

Ithaca researchers asked if it comes back down in the rain. They found that levels of the element in rainfall are no higher in selenium-adequate areas such as North Dakota than in selenium-deficient areas such as New York. Dr. Allaway reasons that since the selenium in rainfall is as high or higher in industrial areas within selenium-deficient areas, much of the selenium in rain is probably coming from combustion of fossil fuels.

It is likely that the selenium from coal combustion is carried down in rain as inert elemental selenium, because selenium deficiency in farm livestock has been found close to coal-burning plants.

Elemental selenium, used in such products as photocopying machines, glass, electronic rectifiers, and photoelectric cells is inert and not likely to get into the food chain.

Man is deliberately altering the levels of selenium in the environment by adding it to feeds for swine and poultry, and inadvertently through burning coal containing selenium and by other industrial processes. When animals eat diets containing selenium, the trimethyl selenium ion (TMSe) is produced in their bodies and excreted in their urine. TMSe is not nearly as toxic to animals as selenate. But, on the other hand, its addition to diets will not prevent selenium deficiencies.

Detectable amounts of selenium from animal manures containing TMSe do get into plants on soils with very low absorptive capacity, but not in amounts that would be toxic to plants or animals. Plants do not metabolize TMSe into biologically active forms.

Soils containing adequate levels of selenium for nutrition may become depleted over long periods of time, according to Ithaca studies. Selenium taken up by plants and then eaten by animals tends to be converted to forms that do not re-enter the food chain.

However, there is not much evidence that man-made pollution of selenium is a hazard in the production of food. □

Curbing boll weevil egg hatch

ERADICATING the cotton boll weevil may be made easier with a new growth inhibiting, urea-type chemical compound, TH 6040, used in sprayable oils or other formulations that aid absorption by contact or feeding.

In studies at the Boll Weevil Research Laboratory, Mississippi State, Miss., and the Southwestern Cotton Insects Research Laboratory, Florence, S.C., TH 6040 shows promise by acting as a female weevil sterilant in both laboratory and preliminary field tests. Actually, it is not a sterilant but inhibits insect development. It does not cause mutation, has very low mammalian toxicity, does not appear to accumulate in the food chain, and prevents hatch of boll weevil eggs.

In the spring, all native female weevils may not respond to pheromone traps or released sterile males. If native males and females mate, the fertile eggs will be in a "clump." When these first generation adults emerge close together, they readily mate and may not respond to pheromone traps or sterile males. As part of research efforts to overcome this obstacle, entomologists at the Boll Weevil Research Laboratory tested formulations of TH 6040 in water, a non-phytotoxic oil, in cottonseed oil formulation, a thickened formulation of cottonseed oil, and invert sugar formulation.

TH 6040 was incorporated as a 25 percent wettable powder blended manually into the different formulations. Cotton plants potted individually were sprayed with the equivalent of 3 gallons of spray per acre. All treatments were repeated four times. Immediately after spraying, the treated plants were caged in 8 by 8 by 15-inch cages in the greenhouse.

Virgin female weevils, 10 per cage, were then released on the caged treated plants and confined there for 3 days, and then placed individually with fertile male weevils. Eggs were collected five times during 18 days following treatment and observed for hatch.

Although the water spray did not appear to be effective, eggs collected from weevils exposed to the oil spray failed to hatch for 10 days after their exposure. All of the bait formulations were highly effective. Results of these tests, however, indicated that when oil is used as a carrier the chemical is absorbed through the body wall. The dosages required for absorption may be greater than for ingestion.

"The new compound TH 6040 has been successfully tested against the gypsy moth in the Northeast and also appears promising for mosquito control," said entomologist Edwin P. Lloyd, working with entomologist Roy E. McLaughlin and biological technician Richard H. Wood at the Boll Weevil Research Laboratory. "Our immediate problem is getting the TH 6040 into the field in a practical way, so that it will effectively prevent egg hatch.

"The boll weevil feeds inside the cotton square, but boll weevils crawl about actively on the plant surfaces. Therefore, both penetration of the material through the body wall in a sprayable oil and ingestion in cotton seed oil and sugar formulations provide methods for using TH 6040. Applications should be repeated at intervals to be effective."

Ultimately, researchers expect to apply TH 6040 at the same time they release sterile males into the field. If it proves effective, TH 6040 could insure that the releases of sterile weevils are 100 percent effective. Also important, costs could be reduced for an eradication program. □

It is July, but this leafless forest reflects the seasonal aspect of late fall or winter as Dr. Beroza and gypsy moth control program staff inspect badly defoliated trees on Cape Cod, Mass. (0770C682-2).

Sex attractant curbs gypsy moth

THE GYPSY MOTH, which has resisted man's efforts to eradicate it since it was brought to the United States about 100 years ago, could be undone by its own sexual instincts.

From 94 to 97 percent reduction in mating of the pests has been obtained in experiments employing a sex attractant that either confuses or traps males seeking mates. Used as a confusing agent, the attractant, incorporated in tiny gelatin capsules, was sprayed over forested areas. The capsules emitted the sex attractant during the entire mating season of the gypsy moths, so confusing males that they died, ex-

hausted, without finding mates. Repeated use of this approach could theoretically result in annihilation of the pest.

Gypsy moths attack several species of forest and ornamental trees and other plants. The insects also pose a direct nuisance to people when large masses of the pests get on buildings, equipment, and in homes.

Until discontinued, DDT held the gypsy moth in check. Other insecticides are environmentally more desirable, but less effective. Thus, the gypsy moth has spread from New England into the Middle Atlantic States, and isolated numbers have been detected in parts of the Midwest and South. In years of heavy infestation, entire forest areas can be stripped of their foliage. Repeated infestations of this kind render the weakened trees more susceptible to diseases and to other insect pests.

Forestry workers of the Massachusetts Department of Natural Resources, led by Stanley Hood, Douglas Trefrey and Edward J. Budnik, carried out experiments with disparlure, the synthetic mimic of the female moth's attractant developed by ARS chemists Morton Beroza and Barbara A. Bierl (AGR. RES., November 1970, pp. 8–9).

These tests, conducted in 1974, involved participation of personnel with USDA's Animal and Plant Health Inspection Service.

Good results have also been obtained in additional tests in Massachusetts in 1975. However, high rainfall reduced the effectiveness of disparlure in Maryland. Nevertheless, a 60-percent reduction in mating was achieved over a 60-square-mile area even though torrential rains caused considerable washing of the compound within a week of application. Dr. Robert M. Altman and Dr. Charles W. McComb, of the Maryland Department of Agriculture, participated in this research.

In 1974, disparlure gave the best results in lightly infested areas in Massachusetts when sprayed by airplane at the rate of 0.28 ounce per acre. A single application of this spray provided 97 percent inhibition of mating. Workers got 94 percent reduction of mating when they made two applications of 0.14 ounce of disparlure, 17 days apart.

The same degree of control resulted in other tests at another area that had potentially heavy infestations. Preseason surveys detected 540 to 1,188 egg masses per acre. This area had been sprayed earlier in the season with carbaryl. Thus, the experiments show that control can be obtained without insecticide in a lightly infested area.

The spray consists of water, a sticky

Dr. Beroza examines graphs that identify the chemically active portion of compound extracted from female gypsy moths. These laboratory experiments led to the development of the synthetic attractant: disparlure (0874X1055–25).

Below left: *Counts are taken of male moths fatally stuck to sticky coating on paper cup baited with disparlure wafer (0874R1270–27).* ***Below right:*** *A single 2-inch long gypsy moth caterpillar may eat several leaves daily. Heavily infested trees may be virtually stripped of foliage overnight. Three successive years of gypsy moth infestation killed more than 1 million oaks, 39,000 Eastern hemlocks, and 8,000 white pines near Newark, N.J. (0972X876–2).*

material, and biodegradable, gelatinous capsules encasing a solution of disparlure. The spray is odorless, colorless, and harmless to man. Disparlure used in these tests cost less than $3 per acre—making it one of the least costly sex attractants.

Entomologist David E. Leonard of the Maine Agriculture and Life Sciences Experiment Station, Orono, examined female moths from the test sites every 3 days for evidence of mating. They had been placed under wood slabs at the test sites and replaced every 3 days during the 6-week test period.

Dr. Leonard found that only 1 percent of the females had mated at the area treated with 0.28 ounce of disparlure. Two percent had mated at the area treated with two applications of 0.14 ounce of disparlure.

In contrast, 30.7 percent had mated in a nearby, untreated area.

In another evaluation of disparlure, the Massachusetts workers used traps containing the lure to survey the number of male moths. At the site treated with 0.28 ounce of disparlure, traps captured 32 males. Traps captured only 22 males at the site sprayed with 0.14

Above: *Forestry worker John Pelczerski mixes solution of tiny capsules impregnated with disparlure. Small amount of water and a sticker are added to facilitate spraying by airplane and increase the adherence of the capsules to forest foliage (0874R1267–9).* ***Below:*** *Spray wreaks havoc in the sex life of the gypsy moth. Capsules in spray give off disparlure for several months to disrupt chemical communication from male to female moths. Thus confused, males' short life span—about 1 to 2 weeks—expires before they find mates. Durability of the disparlure enabled one treatment to handle moths that emerged earlier or later than average (0874R1268–4A).*

ounce. 17 days apart. However, 178 males responded to traps in the untreated control area.

Equally effective control resulted at another area baited with larger traps containing disparlure in plastic dispensers. However, these results may also reflect the effects of earlier applications of carbaryl in this particular test area. Such results may indicate promise for integrated control—the use of more than one approach to pest suppression.

Integrated controls may be most useful when infestation levels are high. After a single application of insecticide, alternate controls may succeed in maintaining control wtihout further use of insecticide. In addition to disparlure, integrated control of the gypsy moth might include use of parasitic wasps whose young prey upon the pests (AGR. RES., September 1973, pp. 3–6). Further tests will be made to determine if such measures can mop up new outbreaks and stop the expansion of the gypsy moth into Southern and Midwestern forests. This work is now part of an expanded Departmental Gypsy Moth Research and Development Program. □

Above: *Natural attractant given off by female in wire cage serves as bait in tests to compare its effectiveness with that of synthetic sex attractant, disparlure, incorporated in plastic strips in paper cup traps. Sticky coating in both types of traps captured males for this survey. Larger, triangular traps baited with disparlure showed potential for both survey and control uses (0774R1071–16A).* ***Left:*** *Female gypsy moth getting ready to emit her sex attractant. She failed to attract a mate because males responded to the stronger lure of disparlure, the synthetic attractant developed by Dr. Beroza and Dr. Bierl (0872X1153–34).*

Sorghums that resist Greenbugs

FARMERS on the Great Plains remember 1968 as the year when greenbugs developed a taste for grain and forage sorghum.

Greenbugs are well-known insect pests of small grains but had caused little damage to sorghum before 1968. Since then biotype C of the greenbug has been a serious threat to sorghum crops throughout a nine-State area.

Using the random-mating technique of breeding, a team of ARS, Nebraska, and Kansas scientists has found that greenbug resistance can be added to existing sorghum breeding material and still maintain other desirable agronomic characteristics. The scientists are thus using a new approach to create greenbug-resistant parent lines useful in producing grain sorghum hybrids.

Developing such parent lines or a field crop variety is a tedious process involving repeated matings and selections from thousands of plants, and typically requiring up to 10 years. If protection against a previously unimportant or new biologic type of insect or disease is to be added, the task becomes more complex.

During the 1968 outbreak, State and Federal scientists searched their nurseries for individual plants or strains showing the least greenbug feeding or the least damage from feeding. These strains proved able to survive under heavy greenbug infestation, and selection for resistance in seedlings proved to be an accurate indicator of resistance in adult plants.

Genetic studies indicated that greenbug resistance is a simply inherited dominant trait in sorghum. Accordingly, if resistance is found on both chromosomes of a pair in one plant, hybrids produced with that parent will be resistant.

The first resistant strains isolated from the sorghum nurseries were unfit for use in producing hybrids because of such undesirable traits as low yield, weak stalks, hard threshing, and susceptibility to disease. Several techniques have since been employed in breeding out undesirable traits while still retaining resistance.

ARS geneticist William M. Ross suggested use of random-mating populations in speeding development of resistant parent lines. With this technique, lines selected for various traits from many sources are grown under conditions encouraging intermating. If genetic diversity is sufficient, breeders can then select simultaneously for such traits as yield, resistance, and plant height instead of adding them one or two at a time, a more lengthy procedure.

In the study, greenbug resistance was added to the sorghum random-mating population KP1BR at Kansas State University's Fort Hays Branch Station. The new population, KP6BR, is constituted as a potential source for both male and female parents of hybrids. The researchers exposed second-generation plants to greenbugs in the greenhouse to select 100 resistant and 100 susceptible plants as the source of seed for progeny evaluation at Mead, Nebr.

The first experiment at Mead checked possible deterioration of other agronomic characteristics when resistance was added. The researchers grew the resistant and susceptible populations in adjacent plots and controlled greenbugs with phorate insecticide. They found no significant differences in average yield, plant height, time to flowering, and kernel weight. But they found enough variability within the population that real gains could be made by selecting for desired traits.

A second experiment at Mead compared the resistant and susceptible populations under a natural greenbug infestation. Under these conditions the resistant sorghum had higher average yield, because of more grain per head and per plant, was taller, and had fewer dead and damaged leaves per plant. Characteristics such as days to flowering and kernel weight were not affected by greenbug feeding.

Effective resistance can thus be added to a random-mating population without sacrifice of other desired traits. And there was sufficient variation in the population to allow improvement by selection toward resistant, agronomically desirable breeding lines used in producing hybrids.

Joining in the study were University of Nebraska research assistant Kenneth D. Kofoid, Dr. Ross, and ARS entomologist S. Dean Kindler, all at Lincoln, and Kansas State University agronomist Harold L. Hackerott and entomologist Tom L. Harvey at Hays, Kan. □

As high-speed traffic on Interstate 90 whizzes by, a Wyoming rancher harvests forage that otherwise would be wasted from the roadside (0775X1127–23).

Roadside harvest

RANCHERS and farmers who are short of hay or want low-cost forage might consider harvesting forage from along highways and median strips. Studies show that adding fertilizer to these areas increases production of forage by up to three times over that produced on similar unfertilized areas.

Other advantages of using this forage are also foreseen by ARS scientists. Scenery is improved for motorists because the fertilizer keeps roadsides greener, longer into the summer. Harvesting the forage would save county and State highway departments time and money spent mowing the right-of-way.

Snow often blocks highways where uncut grass from the preceding summer acts as a natural snowfence for drifting snow. Removing this grass allows the snow to blow across the road rather than collecting on it. Harvesting the hay also cuts down on fires. Harvesting is especially important now that new cars are equipped with catalytic converters. These devices get extremely hot during operation and can start fires if a car is driven onto dry, tall grass areas.

ARS started the research by selecting several plots, ranging in size from 16 by 50 feet to 50 by 104 feet in medians and roadsides along Interstate 90, west of Gillette, Wyo.

The fertilized plots received 80 pounds of nitrogen per acre as ammonium nitrate, and 56 pounds of phosphorous per acre while others served as checks and received none. Fertilized plots produced an average of 1,762 pounds of forage per acre at 12 percent moisture. An average of only 639 pounds of forage per acre was harvested from unfertilized plots.

Range scientist Frank Rauzi says, "Much more forage was harvested from areas closest to the highway than from areas farther away, 2,241 pounds per acre versus 1,306. The rain ran off the impervious surface of the highway and provided more moisture for forage closest to the highway."

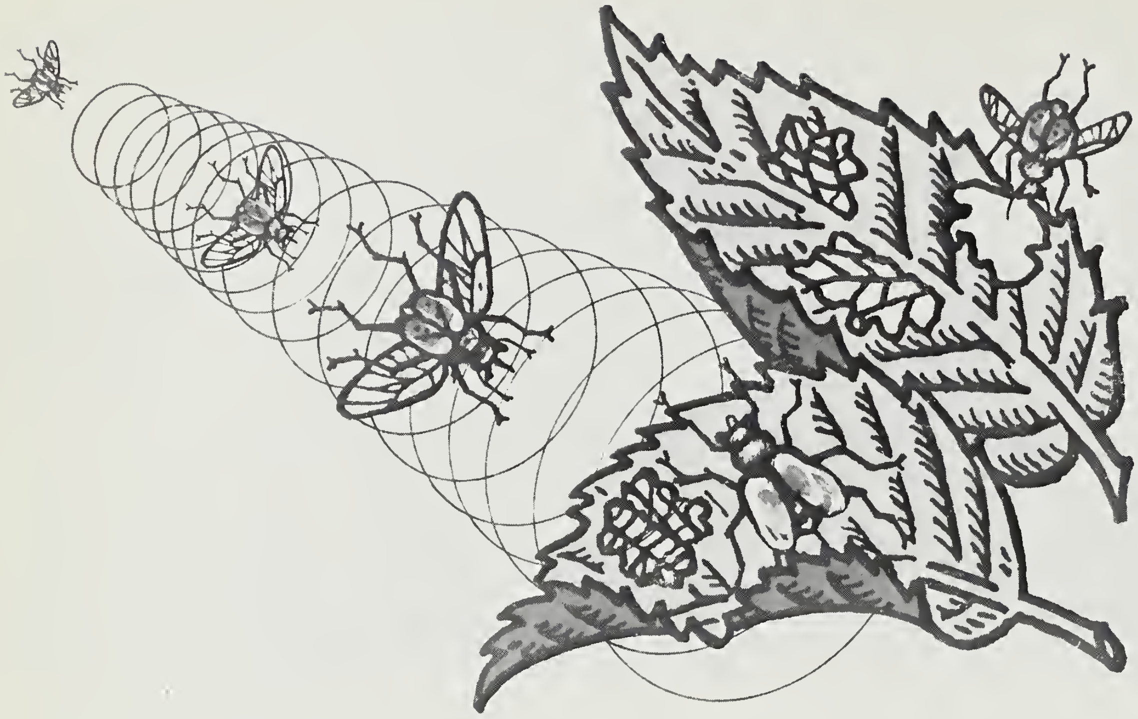
Crested wheatgrass was the dominant species with some alfalfa, yellow blossom sweet clover, and miscellaneous grasses and forbs. Cheatgrass was the dominant plant closest to the highway.

Conducted cooperatively with the Wyoming State Highway Department, Cheyenne, and the Wyoming Agricultural Experiment Station, Gillette, the research shows that crude protein of crested wheatgrass increased from 8.4 percent on unfertilized areas to 11.4 percent on fertilized areas. The calcium and phosphorous levels in both fertilized and unfertilized forage were adequate for livestock nutrition.

Soil textures of medians and roadsides varied considerably because of mixing caused during road construction. Some were clays, others loams and sandy loams. Soil acidity (pH) was nearly neutral on all soils except where weathered coal was mixed with the soil fill.

Precipitation during May and June was about 2¾ inches, approximately 2½ inches below average. Had it been average or above, forage yields would have been greater.

Anyone wishing to utilize this unused resource should first check with local highway departments and secure a permit, if required. The Wyoming Highway Department requires permits for all operations. □



Insects and plant hosts

WHY DO some plants make better insect hosts than others? Research is just scratching the surface of this physiological and chemical interplay. Recent ARS-sponsored research has provided some answers to the question.

Indian scientists, under the direction of Dr. K. N. Saxena, developed a sequential model of how insects respond to specific plant species. The model used two species of leafhoppers, *Empoasca devastans* and *E. kerri motti*, and their preferred hosts, U.S. cotton variety H 14 and castor, respectively. The preferred hosts were used as standards to compare the degree of insect establishment on certain other plants. The other test plants were potato, eggplant, and two varieties of Indian cotton, Jaydhar and Bhoj.

Entomologist Boyd W. George of Mesa, Ariz., the ARS-cooperating scientist, says the model and some of the methodology developed by this project should be useful to U.S. entomologists in developing and testing crop plants that are resistant to U.S. pests. "This information," he says, "should be applicable regardless of whether the insects under study are sap feeders, such as those used by Dr. Saxena, or chewing insects that feed on leaves or other plant parts."

Dr. Saxena's model included six degrees or phases necessary to successful insect establishment on its plant host: (1) orientation, (2) ingestion of food, (3) metabolic use of food, or weight gain, (4) growth, (5) adult survival and egg production, and (6) oviposition.

Orientation and ingestion are behavioral and determine the initial selection of the plant. "Ideally," Dr. George says, "these first two phases are the ones plant geneticists would like to interrupt by manipulating factors that control these behavioral responses."

In his studies, Dr. Saxena found that during orientation and ingestion the most important sensory stimuli from plants for these leafhoppers were visual, water, and contact—either chemical (taste) or mechanical (tactile).

The host plants' green color was the visual attraction for the leafhoppers. Water, either as vapor from transpiration or as a liquid in the sap, was a stimulus in both orientation and ingestion—depending upon the degree of insect desiccation. Certain gustatory stimuli, plant sugars for example, determined the insects' quantitative intake, sucrose being most stimulating, glucose less so, and fructose being ineffective.

Once ingestion begins, the four other phases become the critical factors in determining the insects' degree of establishment. For example, a plant that is good for weight gain, but poor for moulting and metamorphosis (m/m) would not enable the larvae to become adults in as large numbers as the plant that is good for m/m, but poor for weight gain. Therefore, the m/m phase, taken as the growth index, rather than weight gain, is more reliable for comparing the suitability of plants for insect establishment.

Tests of *E. devastans* revealed that eggplant was most suitable for m/m, but H14 was best for weight gain. Next in order, potato and Jaydhar cotton were almost equally good for weight gain and m/m. Castor was poorest.

However, the suitability of the plants for adult survival did not correspond with that for growth, potato being as suitable as eggplant and slightly superior to H 14, the insect's preferred host.

For egg production and ovipositional response of *E. devastans*, the relative suitability of the plants was more or less similar to that for this insect's growth and decreased in this order of efficiency: eggplant, H 14, potato, Jaydhar, Bhoj, and castor.

In contrast to the varying phase responses of *E. devastans* to different host plants, *E. kerri motti* exhibited optimal six-phase responses to its preferred host, castor.

This project was conducted under the provisions of Public Law 480 at the University of Delhi, Delhi, India. □

AGRISEARCH NOTES

Soil compaction harms nodules

SOYBEANS growing on compacted soil may have to depend on expensive sources of nitrogen rather than on atmospheric nitrogen, in contrast to soybeans growing in noncompacted soil. Wheel traffic of tractors and implements in normal field operations compacted the soil, reducing the number and size of nodules on soybean roots in studies on silty clay loam in the upper Corn Belt.

Nodules, or root swellings, on legumes such as soybeans provide sites where certain bacteria take free nitrogen from the air and convert it into a form of nitrogen that the plants can use.

ARS soil scientist Ward B. Voorhees, Morris, Minn., developed wheel traffic patterns on one side of some soybean rows, on both sides of other rows, and on neither side of still others.

Plants in rows without traffic on either side had the greatest number of nodules, while plants with traffic on one side had the greatest nodule mass in the first 2 years of the 5-year study that is still in progress. Next year, Mr. Voorhees plans to measure nitrogen-fixing capabilities of the nodules. This will be done in cooperation with researchers at the Minnesota Agricultural Experiment Station, Lamberton, where he is conducting the studies.

Despite freezing and thawing of soil at the northern experiment site, compaction has persisted over winters. Normal field operations have increased the density of soil to depths of almost 2 feet. Mr. Voorhees said, "This means we may not be able to economically restore the physical condition of the soil through tillage."

Compaction in the surface 12 inches of soil may be alleviated, however, by fall tillage, he said.

Metribuzin sensitivity

ALTHOUGH most commercially grown soybean cultivars show only slight to moderate injury from the pre-emergence herbicide metribuzin, two commercially important cultivars, Semmes and Tracy, can be severely injured or killed by its use in weed-infested soybean fields (AGR. RES., April 1975, p. 15). Now researchers have found that metribuzin sensitivity can be modified by genetic selection and an effective screening method.

The big plus for metribuzin, registered with the Environmental Protection Agency for use on soybeans, is that it controls a large number of annual broadleaf weeds like cocklebur, hemp, sesbania, and jimsonweed. Because metribuzin is valuable to growers, plant scientists chose cultivars Hood—tolerant to metribuzin—and Semmes—highly sensitive—as parental types for a soybean breeding study involving the herbicide. They made crosses and backcrosses by hand pollination of field-grown plants. A total of 27 backcross families resulted from pollinating Hood with pollen from Semmes and Hood first generation (F_1) plants.

Soybean seeds were germinated under greenhouse conditions in lightweight, high water-absorbent vermiculite. After germinating, soybean plants were grown in a nutrient solution; the addition of metribuzin to the nutrient proved to be an excellent means of detecting sensitivity.

In the first test, growing 18 plants of each parent, all Semmes plants were dead 6 days after adding metribuzin to the nutrient solution. All Hood plants and 15 F_1 plants were alive but showed slight injury. Twenty-five percent of the second generation plants died.

In a second test with 27 backcross families, 15 families had no dead plants 6 days after adding metribuzin. In the other 12 backcross families, 25 percent of the plants were killed.

These results show that a single recessive gene controls metribuzin sensitivity in Semmes, a reaction described by the gene symbol *hm* (herbicide metribuzin).

Agronomist Carlton J. Edwards, Jr., and geneticist Thomas C. Kilen of ARS conducted the research at the Delta Branch Experiment Station, Stoneville, Miss., in collaboration with Mississippi plant physiologist William L. Barrentine.

UNITED STATES GOVERNMENT PRINTING OFFICE
PUBLIC DOCUMENTS DEPARTMENT, WASHINGTON, D.C. 20402

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AGRISEARCH NOTES

How much effluent?

THE EFFLUENT trapped in the holding pond of a beef feedlot can replace commercial fertilizer in growing nearby crops. But how much effluent can be used profitably?

Under Nebraska conditions, 20 inches of effluent per acre during the growing season produced maximum yields of sod-planted corn. Each acre-inch of effluent furnished 25.4 pounds of nitrogen and 13.6 pounds of phosphorus per acre in the study.

ARS microbiologists James E. Ellis and Thomas M. McCalla and agricultural engineer Howard D. Wittmuss of the Nebraska Agricultural Experiment Station, Lincoln, compared sprinkler irrigation only and 10 weeks applications of 1, 2, or 3 inches of feedlot effluent per acre. In addition, they used the same application rates on duplicate plots fertilized with 200 pounds of nitrogen per acre.

Grain yields on plots receiving 20 and 30 inches of effluent were unaffected by fertilizer application, Dr. Ellis reports, indicating that the 20-inch rate gave maximum yield response. Corn yields were 18 percent higher with 10 inches of effluent plus fertilizer than with 10 inches of effluent only.

Enough water was put on to carry salts and excess nutrients below the root zone, he says, so harmful accumulations were no problem. Soil solution samples taken 7 feet below the effluent plots contained 4 to 10 times more salts, potassium, and chloride than those from the irrigated plots.

Controlling midge in guar

NOT IF or how but *when* is the key word in the control of midges, a serious pest of guar.

An increasingly important crop of Texas and Oklahoma, guar is grown for its seed which is in demand for use in prepared foods and as a lubricant in oil drilling. The plant is also a soil-building legume.

Recent research by ARS entomologist C. E. Rogers and geneticist R. E. Stafford has shown that insecticides must be applied between 45 and 90 days after guar plants have emerged from the soil to be effective against midges. The use of insecticides at any other time would be merely wasteful. Moreover, it could even result in killing the natural enemies of the pest.

Midges decimate guar by laying eggs in the buds. The eggs develop into larvae and cause the buds to abort before pollination. This severely reduces the production of seed.

A 3-year study of the plant's reproductive pattern showed that ¾ of the buds in guar are produced between 45 and 90 days after emergence. The study also showed that only the destruction of 30 percent or more of the buds during this period had any effect on seed yield. Thus, the appropriate time for midge control is during the crucial 45 days of maximum bud production.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

PROTECT
Use Pesticides Safely
FOLLOW THE LABEL

U. S. GOVERNMENT PRINTING OFFICE : 1975 O - 593-453